AOARD REPORT

Visit of South Korea's Electronics Telecommunications Research Institute (ETRI)

30 June 94
S. J. Yakura
AOARD

South Korea's Electronics Telecommunications Research Institute (ETRI) was visited on 30 June 94. The intent of the visit was to learn about basic and advanced research carried out in electronics and telecommunication fields at ETRI and also to establish initial contacts with ETRI personnel for any future interactions in setting up collaborative research programs which can benefit both the US Air Force and ETRI.

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

ASIAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

TOKYO, JAPAN
UNIT 45002
APO AP 96337-0007
DSN: (315)229-3212
Comm: 81-3-5410-4409

Visit of South Korea's Electronics Telecommunications Research Institute (ETRI)

Daeduck Science Town
Yusong Post Office Box 106
Taejon 305-600, Republic of Korea

by

S. Joe Yakura, AFOSR/AOARD
(22 July 1994)

abstract

South Korea's Electronics Telecommunications Research Institute (ETRI) was visited on 30 June 94. The intent of the visit was to learn about basic and advanced research carried out in electronics and telecommunication fields at ETRI and also to establish initial contacts with ETRI personnel for any future interactions in setting up collaborative research programs which can benefit both the US Air Force and ETRI.

I. General Information

Dr. Tom E. Davis and I visited the Electronics Telecommunications Research Institute (ETRI) in the morning of 30 June 94. ETRI is located in Daeduck Science Town, Taejon, South Korea. The intent of the visit was to learn about basic and advanced research carried out in electronics and telecommunication fields at ETRI and also to establish initial contacts with ETRI personnel for any future interactions in setting up collaborative research programs which are beneficial to both the US Air Force and ETRI. The visit was arranged by Mr. F. Kenneth Crosher of the Science Counselor Office, US Embassy in Seoul, South Korea.

We were greeted by Dr. Seungtaik Yang, President of ETRI; Dr. El-Hang Lee, Director of Research; and Dr. Inseok Han, Supervisor of Protocol and Secretarial Group. Dr. Hyung Moo Park, Director of Compound Semiconductor Department, joined us later in the meeting when we started discussing technical aspects of ETRI's semiconductor research. He had keen interest on III-V wide bandgap material research when I mentioned to his that I am planning to hold a GaN workshop in Japan sometimes in the late summer of 1995. The following are phone numbers and e-mail addresses (if available) of above mentioned personnel we met at ETRI:

Dr. Seungtaik Yang, President of ETRI
Tel: +82-42-861-9564; Fax: +82-42-861-1033
E-mail: yang@ketri-etri.re.kr

Dr. El-Hang Lee, Director of Research-Basic and Advanced Technology
Tel: +82-42-860-6861; Fax: +82-42-860-5033
E-mail: ehlee@ard.etri.re.kr

Dr. In-Seok Han, Supervisor of Protocol and Secretarial Group
Tel: +82-42-860-6687; Fax: +82-42-860-5002

Dr. Hyung-Moo Park, Director of Compound Semiconductor Department
Tel: 82-42-860-6835; Fax: +82-42-6200
E-mail: hmpark@cadvax.etri.re.kr

First, I made a brief presentation of the AFOSR/AOARD activity, describing the mission of my office, office personnel and their research interests, Window-on-Science and Window-on-Asia programs (scientist exchange programs), and the Contract Support program. I gave copies of AFOSR pamphlets, which described AFOSR research interests and selected 1994 research highlights. I gave these pamphlets to ETRI personnel as additional information about the operation of AFOSR Headquarters in Washington, D.C.

Following my talk, Dr. Yang gave the general background of ETRI, basically to give us the brief history, the mission, the organization structure, and types of research work being performed at ETRI. After a short chat, which lasted for about 15 minutes, Dr. Yang had to excuse himself to attend some other official meetings in Seoul. Before he left he kindly left us with copies of the 1994 ETRI annual report which contained detailed information of ETRI's current research activities. We continued the discussion with other three ETRI personnel. They informed us that the total operating budget of ETRI is around $180 million with $150 million going into research and development efforts. The budget supports the direct payroll of around 1,800 personnel of which more than 1,500 have technical degrees. Of 1,500, there are around 300 PhDs. If contractors are included as part of the total man-power force, there are more than 2,300 personnel working within ETRI facilities.

II. History

The history of ETRI is not that old. It all started with the establishment of the Korea Institute of Electronics Technology(KIET) in December, 1976 which came under the Ministry of Commerce and Industry. Exactly one year later, the Korea Telecommunication Research Institute (KTRI) was established in December, 1977 under the Ministry of Communications. In March, 1985, KIET and KTRI were merged to form the Electronics and Telecommunications Research Institute (ETRI), which we know as of the institute today. At that time the institute was under the control of the Ministry of Science and Technology. Then, in March, 1992 the control of the institute was moved to the Ministry of Communications

III. Research and Development (R&D) Efforts

Because there are many useful information contained in ETRI's 1994 annual report, I am presenting in this section the condensed version of ETRI's R&D activities. Basically, ETRI's R&D is divided into five major categories. They are 1) Research on Basic and

Advanced Technologies, 2) Semiconductors, 3) Computers, 4) Telecommunications, and 5) Information Technology. These categories are established for the purpose of satisfying ETRI's long term objectives which provide high level information and telecommunications services to Korean people in the 21st century and expanding the market share of the Korean electronics and telecommunication technologies in the world.

Within each category there are a number of specific R&D activities. They are outlines as follows.

In the Research on Basic and Advance Technology category, there are
- o Physical science research
- o Communications Science Research
- o Information Science Research
- o Material & Engineering Research

In the Semiconductor category, there are
- o High speed digital signal processor design technology
- o Development & research for advanced silicon devices
- o Compound semiconductors
- o Application Specific Integrated Circuit development center

In the Computer category, there are
- o Development of the high performance computer, TICOM III
- o Multimedia computer technology
- o Distributed system software technology

In the Telecommunication category, there are
- o Intelligent network technology
- o Communication processing technology
- o Transmission Technology
- o R&D of B-ISDN technology
- o Human interface technology
- o TDX-ISDN and application system
- o ATM switching technology
- o Digital mobile communications system development
- o Utilization technology of radio wave resources
- o Satellite communications technology

In the Information Technology category, there are
- o Standardization activities in information and telecommunications technology
- o Development & support of application technology
- o Technical information center
- o Computer application technology

To bring the South Korean economy to the level of developed countries, ETRI has taken up a leading role in advancing electronics and telecommunication technologies into the next

century. Their current R&D efforts are focused on advanced research, communications network, transmission, switching, mobile communications, satellite communications, computer, and semiconductor.

According to Dr. El-Hang Lee, Director of Research, ETRI is spending around $1.0 million in 1994 for basic and advanced research. He said his research group is focusing specifically in the areas of solid states, quantum effects, and optics/photonics. At present there are 58 staff members working in his group. Of which about 40 hold PhDs. With only six years in existence, the basic and advanced research group has presented or published over a hundred papers in major international journals and conferences around the world. Also about the same number of papers were published in domestic journals. I got the strong feeling that by talking with Dr. Lee the quality of their research has vastly improved in last couple years and now they are ready to catch up to the level of US and Japanese research. However, after getting a tour of his laboratory facilities, I concluded the level of research is still far behind that of many of the Japanese research institutions.

In the area of communication network, ETRI is striving forward to develop an ultra-high-speed communication network system based on advanced communications network, the Broadband-Integrated Services Digital Network (B-ISDN), the Advanced Intelligent Network (AIN), and the Universal Personal Telecommunications (UPT). They are one of the major players of the national B-ISDN project, trying to come up with low cost Broadband Network Terminal (BNT) optical modules for 155 Mbps date transmission and laser diode devices for ultra high speed 10 Gbps data transmission.

In the transmission area, ETRI, in support of building a national communication network system, is actively involved in the development of 10 and 100 gigabits/second transmission systems, the Broadband Digital Cross-connect System (BDCS), the Synchronous Digital Hierarchy (SDH), and the BNT system.

In the switching area, ETRI is stepping up the efforts in both the development of a large scale Asynchronous Transfer Mode (ATM) switching system which is based on 16x16 limited shared memory structure devices and a photonic switching system which is based on 2.5 Gbps switching unit with mixed switching and time slot interchanging functions.

In mobile communication, ETRI, as an effort to provide commercial mobile communication service by 1995, launched a six year project with QUALCOMM Inc., USA in 1989 to develop a Code Division Multiple Access (CDMA) system. Thus far, the project has been successful in completing the CDMA digital and cellular system architecture design, prototyping the cell controller called the Base-station Transceiver Subsystem (BTS), and deploying the Home Location Register (HLR) for the purpose of carrying out stand-alone tests. The major development activity left 1994 or possibly in 1995 is the operational testing of the first commercial system.

ETRI is actively involved in establishing satellite communication capabilities. They are planning to launch the first domestic satellite called the Koreasat, which is scheduled in early part of 1995. The Koreasat provides telephone, video, and data services to public

and private business offices. The Direct Broadcasting Service (BDS) will expand the broadcasting coverage over the whole Korean peninsula once completed. To meet the scheduled launch date, thus far ETRI has developed a satellite communication modeling tool, completed the detailed design of lab-model payload subsystems, developed a satellite ground control unit, completed a communications satellite monitoring system for a test bed, and completed the integration testing of the VSAT system and the DAMA/SCPC system which are used for earth stations.

In the computer area, ETRI is working in the development of high performance computers, multimedia information processing computers, and distributed network systems.

The high performance computer project called TICOM III, which started in July 1991 at the estimated cost of about $37.5 million with four major Korean companies, i.e., Daewoo, Goldstar, Hyundai, and Samsung, is aiming to advance the Korean computer technology into the era of multiprocessors. The major features of TICOM III computers include the multiprocessor architecture expandable up to 10 Intel's Plentium processors with a maximum handling capability of 2 gigabytes for main memory, an input/output bus using VME64 and SCSI-II, an operating system whose volume manager is adapted as the kernel of the UNIX system V Release 4 MP, and communication software packages with various services and protocols which meet international standards, such as the DCE and the DBMS massive storage. ETRI expects the TICOM III computer to be used first as the host computer of the national information system and then working horse computers at many other Korean government agencies. Upon successful operation of the computer, ETRI is intended to introduce them to the Korean public sector with the hope of occupying the mid-range computer market share of over 30% in Korea.

For the development of multimedia information processing computers and distributed network systems, the South Korean government created national R&D projects called the "Mutimedia Workstation" in 1990 and the "Distributed System Software Technology Development" in 1993, respectively, to build an intelligent multimedia workstation by 1998 and develop a prototype of distributed network software for testing by 1995.

In the area of semiconductors, ETRI is very active in integrated circuit design technology for information communications and compound semiconductor devices.

One of the major efforts is the development of high speed digital signal processors for hand-held multimedia terminals and the hand-held phones. Since the signal processing for hand-held multimedia terminals or phones require high speed, high resolution, low power analog-to-digital conversion, real time processing, and transmission of converted digital signals, ETRI has set up the following three goals to develop necessary technologies in the 1993 through 1996 time frame: 1) 32bit/200MIPS high speed DSP, 2) 3.3V 50mw 10bit/20MSPS ADC, and 3) 3.3V 10bit/80MHZ DAC. In support of these goals, ETRI has established projects in the Field Programmable Gate Array (FPGA), the SiGe/Si strained layered heterostructure growth, and the growth of epiwafer for SiGe/Si heterojunction bipolar transistor. In 1993, the first year of the four year projects, ETRI

was able to develop a 5V, 50mw prototype, a 10bit/20MSOS video rate ADC, design a 16bit, 35MIPAS vocoder DSP for digital cellular phone and a 3 chip-version CDMA mobile modem, and design a 32bit, 100MIPS multiplier generator as a part of the high speed DSP main function blocks.

In compound semiconductor research, ETRI has more than 40 technical staff members working mainly on development of III-V electronics and optical devices. It is one of the largest compound semiconductor research groups in Korea. The research effort is carried out at a 3600 square feet, clean room laboratory, dedicated solely for compound semiconductor fabrication. The laboratory is fully loaded with dozen kinds of modern equipment for processing, monitoring, and characterizing up to 3-inch GaAs wafers. In 1993, noteworthy accomplishments of the group were 1) the development of the GaAs MMIC cell library composed of 3 kinds of MESFET with gate lengths of 1 and 5 microns, 53 kinds of inductors, 7 kinds of capacitors, and 4 kinds of NiCr resistors, 2) the development of a low noise High Electron Mobility Transistor (HEMT) with a noise figure of 0.65 dB, 3) the development of a high speed HBT with a cut-off frequency of 40 GHz. These devices are intended to become building blocks of their research efforts in 1994.

IV. Concluding Remark

Compared with the rest of Korean research institutes we visited during our trip to Korea, I rate ETRI as one of the top Korean research institutes. They have most extensive and advanced research projects line up to compete eventually with the rest of leading research institutions/laboratories/centers in the world. The focus of basis research is in line with US and Japanese research efforts; however, they have a long road ahead of them to make any impacts in the basic research arena. Considering that ETRI is one of the prominent leaders in carrying out basic research in electronics and telecommunication fields in Korea, I cannot see how one can make a great stride forward by spending just $1.0 million in basic research. It might be the case that ETRI's main objective is to develop a strong industrial base for manufacturing technology in Korea based on existing technologies available in Japan and the US. If that is the case then ETRI is doing a superb job in transferring technologies to their industry. They have many projects working together with Korean industrial firms such as Daewooo, Goldstar, Hyundai, and Samsung.

The bottom line of my observation about ETRI is that ETRI is making fast progress in catching up US and Japanese electronics and telecommunication technologies, especially in the area of manufacturing high performance electronics and optical devices. I would say their technology is a few years behind that of the US and Japan.